The History of Mars Revisited via the Petrological and Geochemical Study of Martian Meteorites

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Key advances have been made in understanding the geological history of Mars via the study of Martian meteorites—our only samples from this planet. Each time a new meteorite from this planet is found, potential huge strides in this science can be made. A team of scientists at Johnson Space Center (JSC), the University of Alberta, and the University of Houston concentrated on the petrological study of a Martian meteorite—called LAR 06319—found in Antarctica in 2006. Detailed petrological study revealed that this meteorite represents a sample from lava erupted at the surface of Mars. The importance of this meteorite is that its minerals represent an entire sequence of snapshots of the history of the magma from the time it left the depths of the Martian mantle to the time it reached the surface of the planet. By carefully determining the temperature and oxygen fugacity conditions at which these minerals formed at these various times throughout the history of this magma, the team could show that information about the chemical and physical conditions in the source of Martian magmas can be lost during the evolution of the magma after it has left the Martian mantle. However, the team could use this particular meteorite—having preserved all the information from its source to its eruption—to redefine the conditions pertaining at the source of Martian magmas. This study makes it easier to model the magmatic history of Mars by narrowing the range of oxygen fugacity of the source Martian magmas.

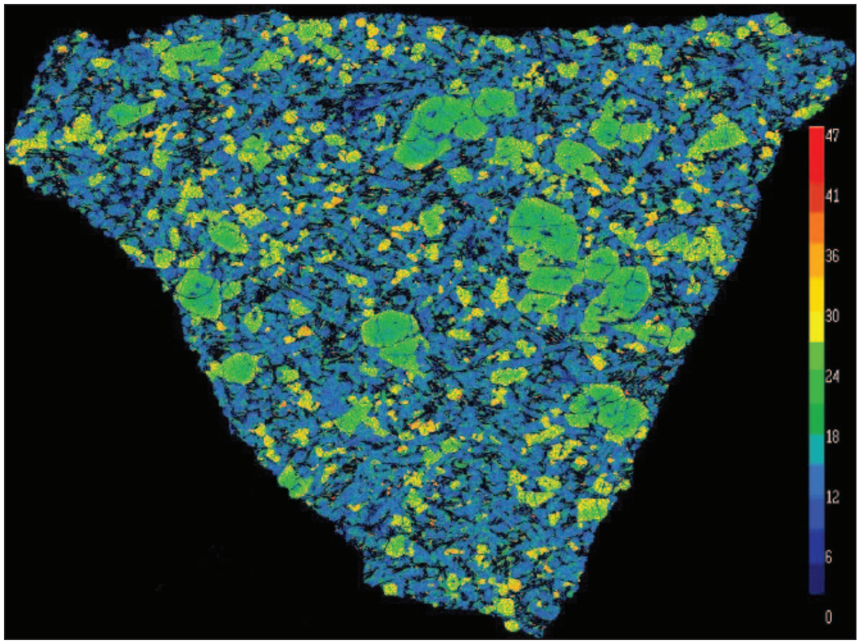

Fig 1. *The figure shows a map of the iron content of a thin slice of the Martian meteorite LAR 06319. The sample is about 2 centimeters at its widest side. The large green minerals formed first in conditions closed to that of the source of the magma deep in the Martian mantle, while the thin needle-like black ones most likely formed at eruption at the Martian surface. Blue indicates low amounts of iron, while orange–reds means large amounts of iron.*

Scientists at JSC also collaborated with University of Houston scientists in refining the timeline of volcanic activity on Mars with the precise dating of the oldest Martian meteorite ALH 94001 and the age determination of the meteorite LAR 06319. These studies affirm that only one Martian meteorite is very old (ALH 94001 is more than 4 billion years old), while all others are samples of magmas erupted on the Martian surface much later—less than 600 million years ago. All these results constrain models of planetary formation and evolution.